SD77-MSFC-2149

SD77-MSFC-2149

Technical Report

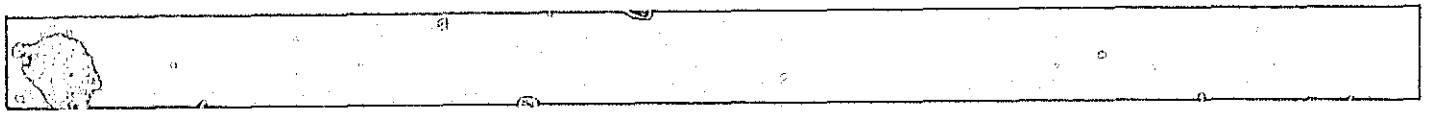
SURVEY: FEDERAL AVIATION ADMINISTRATION NATIONAL COMMUNICATION CENTER

(NASA-CR-150552) SURVEY: FEDERAL AVIATION ADMINISTRATION NATIONAL COMMUNICATION CENTER (Teledyne Brown Engineering) 31 p
HC A03/MF A01 CSCL 17B

N78-13262

Unclas
G3/32 05933

October 1977



TELEDYNE
BROWN ENGINEERING

Cummings Research Park • Huntsville, Alabama 35807

TECHNICAL REPORT
SD77-MSFC-2149

SURVEY: FEDERAL AVIATION ADMINISTRATION NATIONAL COMMUNICATION CENTER

Prepared For

DATA SYSTEMS LABORATORY
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

Contract No. NAS8-[illegible]539

APPROVED:

O. P. Ely
Project Director

INTRODUCTION

The National Communication (NATCOM) Center (commonly known as the FAA Weather Message Switching Center), located in Kansas City, Missouri, is a Federal Aviation Administration (FAA) facility with responsibility for providing communication switching services to the National Weather Service (NWS), the FAA, commercial and private flight organizations under the auspices of the FAA, and DoD. Data handled by NATCOM include weather data, flight plans, and Notices to Airmen (NOTAMs) on both national and international networks. The communications and data management functions are handled through four computer-controlled communication networks designated as WMSC, AFTN, A-BDIS, and NASNET. The functions of these networks are discussed in subsequent paragraphs, with emphasis on those networks that support the different elements of the NWS. The primary network of concern to NASA, the WMSC (Weather Message Switching Center) network, performs approximately 60% of its work for the NWS, 20% for the State Department, and 20% for the FAA.

The role of NATCOM will change significantly with the implementation of the NWS Automated Field Operations and Services (AFOS) system in the early 1980s. The principal changes will be a reduction of data flow between NWS elements via the WMSC network and certain changes in the data base requirements within the WMSC computer center. The data flow between NWS elements and the NWS data base will be maintained by the AFOS system. FAA users and certain other users (e.g., private individuals and organizations that use weather data) will very likely continue to use the WMSC because the financial impact of changing to the AFOS would be too great. Also, the switching center will continue to collect weather data from the FAA Field Service Stations for use by the NWS in its weather forecast. The WMSC system will continue to be the interface between the FAA and the NWS and between the NWS and certain private users. This document discusses the current and future systems capabilities and workload of NATCOM in terms of these new roles.

The current NATCOM system provides direct service via 337 leased service circuits and 129 FDM multiplex channels to the area bounded by Hawaii on the west, Alaska to the north, Portugal to the east, and Peru to the south.

1. DATA GENERATOR ELEMENTS

Not applicable.

2. SPACE DATA PROCESSING ELEMENTS

Not applicable.

3. SPACE DATA STORAGE ELEMENTS

Not applicable.

4. SPACE DATA HANDLING ELEMENTS

Not applicable.

5. SPACE-TO-GROUND COMMUNICATION ELEMENTS

Not applicable.

6. PRE-PROCESSING ELEMENTS

Not applicable.

7. PROCESSING ELEMENTS

7.1 WMSC PROCESSING ELEMENTS

The Weather Message Switching Center provides message store and forward services via a computer-controlled communication system that is the principal interface between national, regional, and local centers of the NWS. In addition, the WMSC provides international data links and end-user links to various other Government and private organizations via this same network. Messages consist of alphanumeric (narrative and formatted) text and medium- and high-speed digital data.

7.1.1 WMSC Data Input

The WMSC network handles weather messages via the Service A, Service C, and Service O networks (See Section 9) and NOTAM messages via both low-speed and high-speed lines into and out of the switching center.

Data throughput on this network is as follows:

- Daily Average Weather Messages
  - Input: 235K
  - Output: 1.6M
- Daily Average NOTAMS
  - 695 - Active
  - 298 - New
  - 281 - Cancelled.

The average throughput for the above messages translates to approximately 4×10^6 characters per hour.

7.1.2 WMSC Data Products

The data products or outputs are:

- Real-time verbatim messages transferred to scheduled recipients according to address
- Stored verbatim messages from the WMSC data base on a request basis

- Formatted data, stripped of narrative information, for input to computers (NSSFC, NMC, etc.) on either a request or a pre-programmed basis

- Formatted data, recallable from the WMSC data base on the basis of need (alphabetical, regional, state, etc.).

7.1.3 WMSC Data Processing Hardware

The WMSC processing configuration is illustrated in Figure 7-1 and consists of the following hardware elements:

- Five Phillips DS-714 CPUs with 240K word memory
- Two CDC 9434 disks (48M characters)
- Three CDC 9742 disks
- Two Bryant drums (6M words) - contains on-line data base
- Eight 9-track tape drives
- Four CRT displays
- One Data Products line printer.

During normal operations, one of the above processors is used for inputting data, one is used for output, and the remaining units are used for running updates and statistics. In the event of a failure on one or more of the on-line units, the remaining units assume the load. The level of redundancy assures continuous communications capability. A front-end processor (Section 9) handles communications.

7.2 AFTN PROCESSING ELEMENTS

The Aeronautical Fixed Telecommunications Network (AFTN) is an FAA network for handling international flight plans, weather forecast information, and NOTAM messages. The network operates in a store and forward mode and maintains a data base of pertinent NOTAM messages and current flight plan data that are needed for the preparation of new flight plans.

7.2.1 AFTN Data Input

Daily throughput of international flight plans, meteorological messages, and NOTAMs on this network is as follows:

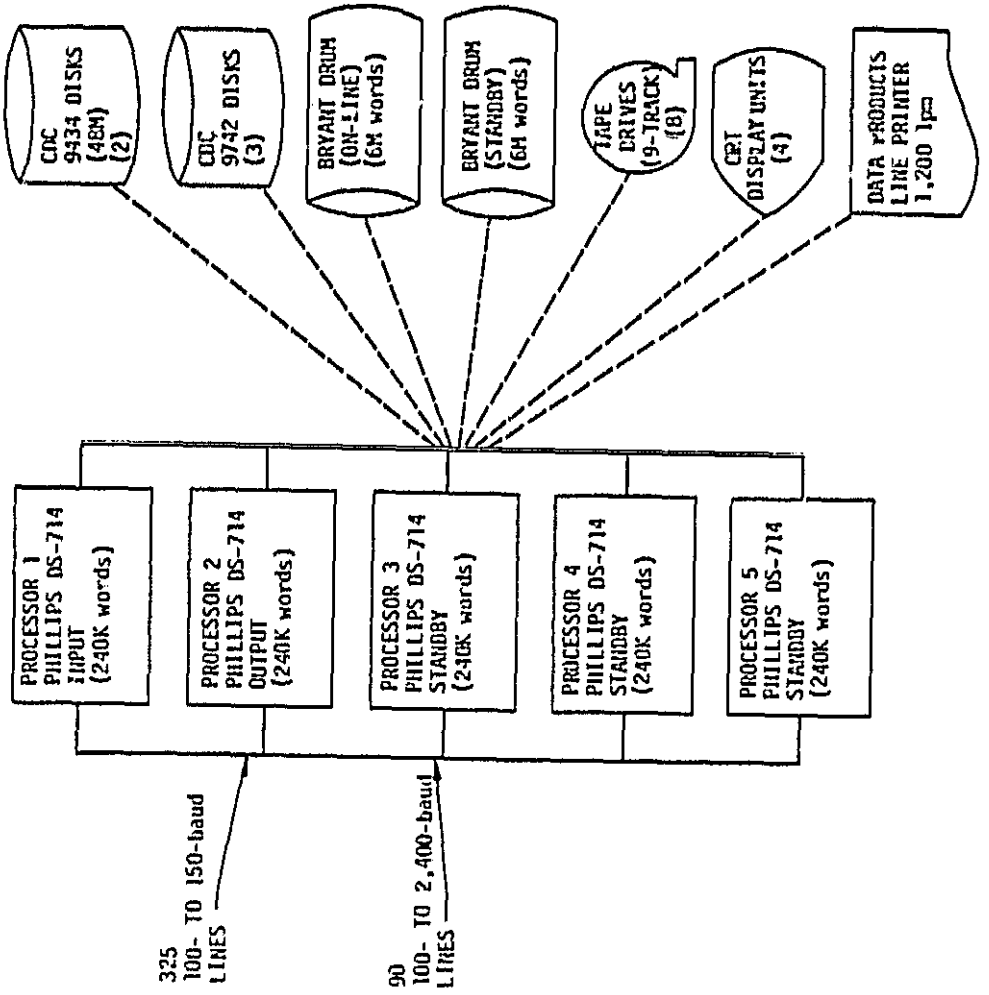


FIGURE 7-1. WMSC DATA PROCESSING SYSTEM CONFIGURATIONS

- Daily Average Messages

  48K AFTN messages
  10K Meteorological messages
  58K Messages.

This average throughput translates to approximately 650K characters per hour.

7.2.2 AFTN Data Products

The data products or outputs generated are:

- International flight plans, weather forecasts, and NOTAMs from the AFTN data base
- Real-time verbatim messages to scheduled recipients according to address
- Stored verbatim messages from the AFTN data base on a request basis.

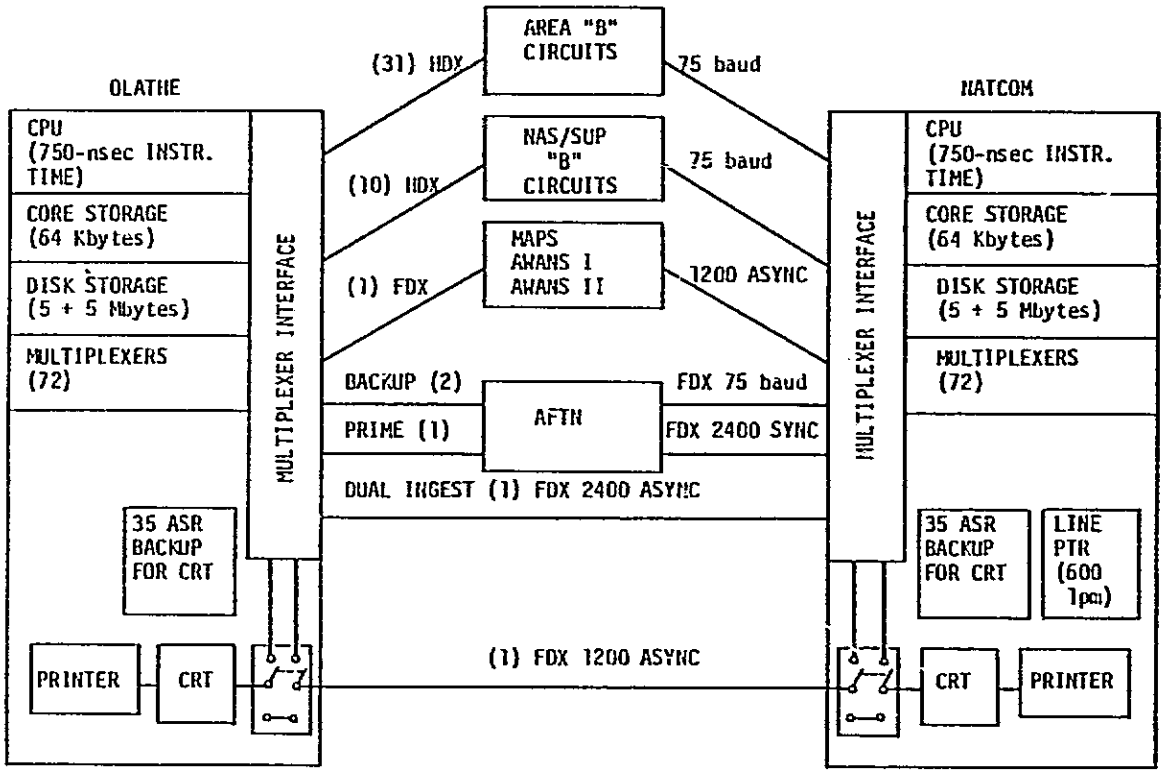
7.2.3 AFTN Data Processing Hardware

The AFTN processing configuration consists of the following hardware elements:

- Two Phillips DS-714 CPUs with 240K word memory
- Two Bryant drums (2.5M words).

7.3 A-BDIS PROCESSING ELEMENTS

The Advanced Service B Data Interchange System (A-BDIS) handles communications pertinent to FAA Flight Service Stations (FSSs). It handles messages for IFR flight plans [between an FSS and an Air Route Traffic Control Center (ARTCC)], VFR flight plans (between FSSs), and FAA administrative control traffic. The A-BDIS system is located at Kansas City; however, a mirror-image contingency backup system is located at Olathe, Kansas, about 30 mi SSW from NATCOM. The Olathe facility is also placed into service when NATCOM is undergoing preventive maintenance. There are 323 FAA locations involved in the A-BDIS system. The general configuration is shown in Figure 7-2.



48 OF 72 PORTS ARE IN USE.
OF THE 24 SPARES, 8 ARE EIA AND 16 ARE LOOP CURRENT.
ANY PORT CAN BE CONVERTED FROM A 75-baud CURRENT LOOP
TO A 1200 ASYNC EIA FOR A COST OF $225.

FIGURE 7-2. GENERAL CONFIGURATION OF A-BDIS

7.3.1 A-BDIS Data Input

A-BDIS handles IFR flight plans between FSSs and ARTCCs, VFR flight plans between FSSs, and FAA administrative traffic.

Daily throughput on this network is the following:

- 505K AM characters per hour
- 556K PM characters per hour.

7.3.2 A-BDIS Data Products

The data products or outputs generated by A-BDIS are:

- IFR flight plans between FSSs and ARTCCs
- VFR flight plans between FSSs
- FAA administrative messages such as delayed flight announcements.

7.3.3 A-BDIS Data Processing Hardware

The A-BDIS data processing configuration consists of two GTE IS/1000 CPUs (one at NATCOM, one at OLATHE) with 64 Kbytes of main storage and two 5-Mbyte disks at each site.

7.4 NASNET PROCESSING ELEMENTS

The NASNET system is used for transmitting FAA software and administrative messages. It polls each of the 20 U.S. ARTCCs to determine whether it has a message to be transmitted. If it does, the system then determines how many and which stations are to receive the message. Then each station that is indicated is queried to see whether it is ready to receive the message and the message is sent. After transmission of the message is complete, a verification check is made to ensure that the receiving station copied the message correctly. In the event a station does not receive correctly, the message is retransmitted over and over until either a correct message is received or it is established that transmission at this time is not feasible.

7.4.1 NASNET Data Input

The NASNET system receives and transmits FAA messages verbatim between ARTCCs in a polled environment.

7.4.2 NASNET Data Products

NASNET provides for verbatim transfer of messages in real time according to address.

7.4.3 NASNET Data Processing Hardware

The NASNET system uses a NOVA 1200 minicomputer. The system does not store a data base on mass storage devices.

8. DATA BASE SYSTEM ELEMENTS

8.1 WMSC DATA BASE SYSTEM ELEMENTS

The on-line data base for the WMSC is highly perishable and that portion pertaining to weather is updated hourly. Beginning on the hour, approximately 500 terminals are polled to obtain the most recent observation data, and the data base is updated. The software that maintains the data base was developed by the FAA especially for this application. The data are entered into the data base on a station-by-station or terminal-by-terminal basis, and it can be output on request by either region or state or alphabetically. In addition, key data of interest to the NSSFC and NMC are organized into a format for use by these organizations.

The data within the data base are output to magnetic tape during each collection interval. Then, once a week, the contents of these tapes are combined into a data base on magnetic tape in IBM-compatible format and sent to the National Climatic Center (NCC) in Asheville, N. C., for archival and future climatic research.

8.2 AFTN DATA BASE SYSTEM ELEMENTS

The AFTN system maintains a "history" of the messages that have passed through the system, although it is basically a message store and forward operation. Messages are stored on two 2.5-Mbyte drums.

8.3 A-BDIS DATA BASE SYSTEM ELEMENTS

Not applicable.

8.4 NASNET DATA BASE SYSTEM ELEMENTS

Not applicable.

9. DATA DISTRIBUTION ELEMENTS

9.1 WMSC DATA DISTRIBUTION ELEMENTS

The WMSC data distribution network is configured as illustrated in Figure 9-1. The network services national NWS organizations over the Service A, Service C, and Service O networks, which are described in subsequent paragraphs. The center also provides local and regional weather data distribution, along with special service via satellites to Alaska and Honolulu. Others served by this switching center include airlines and certain companies performing FAA-related work and a number of special circuits, some of which are discussed in Section 11 in relation to future plans for the FAA network. Pertinent acronyms and abbreviations associated with Figure 9-1 are defined and discussed in the following paragraphs.

9.1.1 Service A Network

The Service A network is a 100-word-per-minute (wpm) long-line teletype network that is used to collect and distribute hourly surface aviation observations and to disseminate products of the Aviation Weather Service and NOTAMs. The Service A network provides services to five classes of users as follows:

- FAA - This Government network contains 46 100-wpm area circuits (40 in the contiguous states, 4 in Alaska, and 1 each in Hawaii and Puerto Rico), as illustrated in Figure 9-2, and 40 100-wpm request and reply (R/R) circuits with essentially the same boundaries as presented in the same figure. These circuits are illustrated as R/R FSS (field service station) Levels I and II in Figure 9-1. In addition, the WMSC services 66 point-to-point request and reply circuits to 66 of the FAA's high activity field service stations (designated as R/R FSS Level III in Figure 9-1) and 20 point-to-point circuits to Air Service Air Route Traffic Control Centers in the continental U.S. and Puerto Rico.

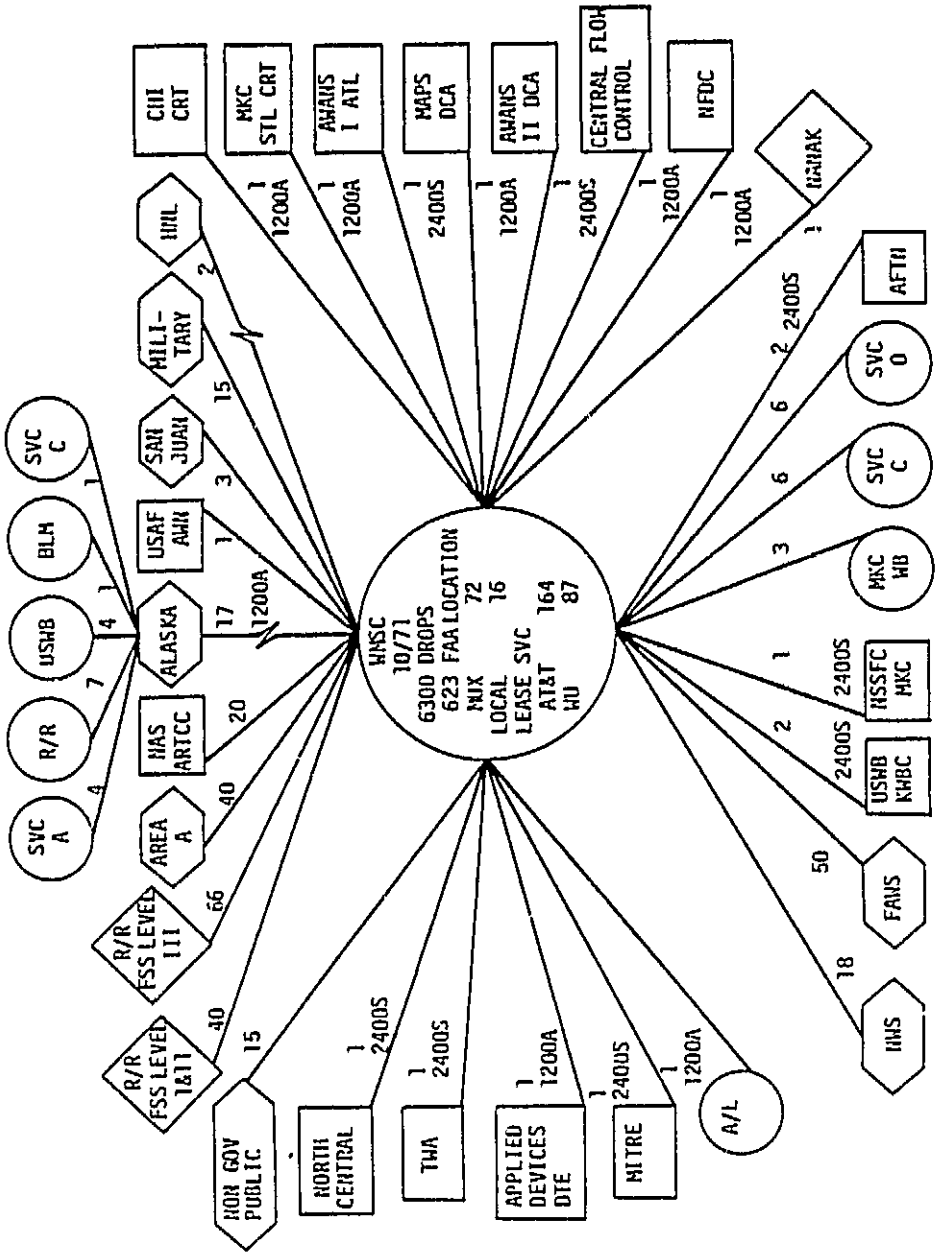


FIGURE 9-1. WMSC DATA LINE CONFIGURATION

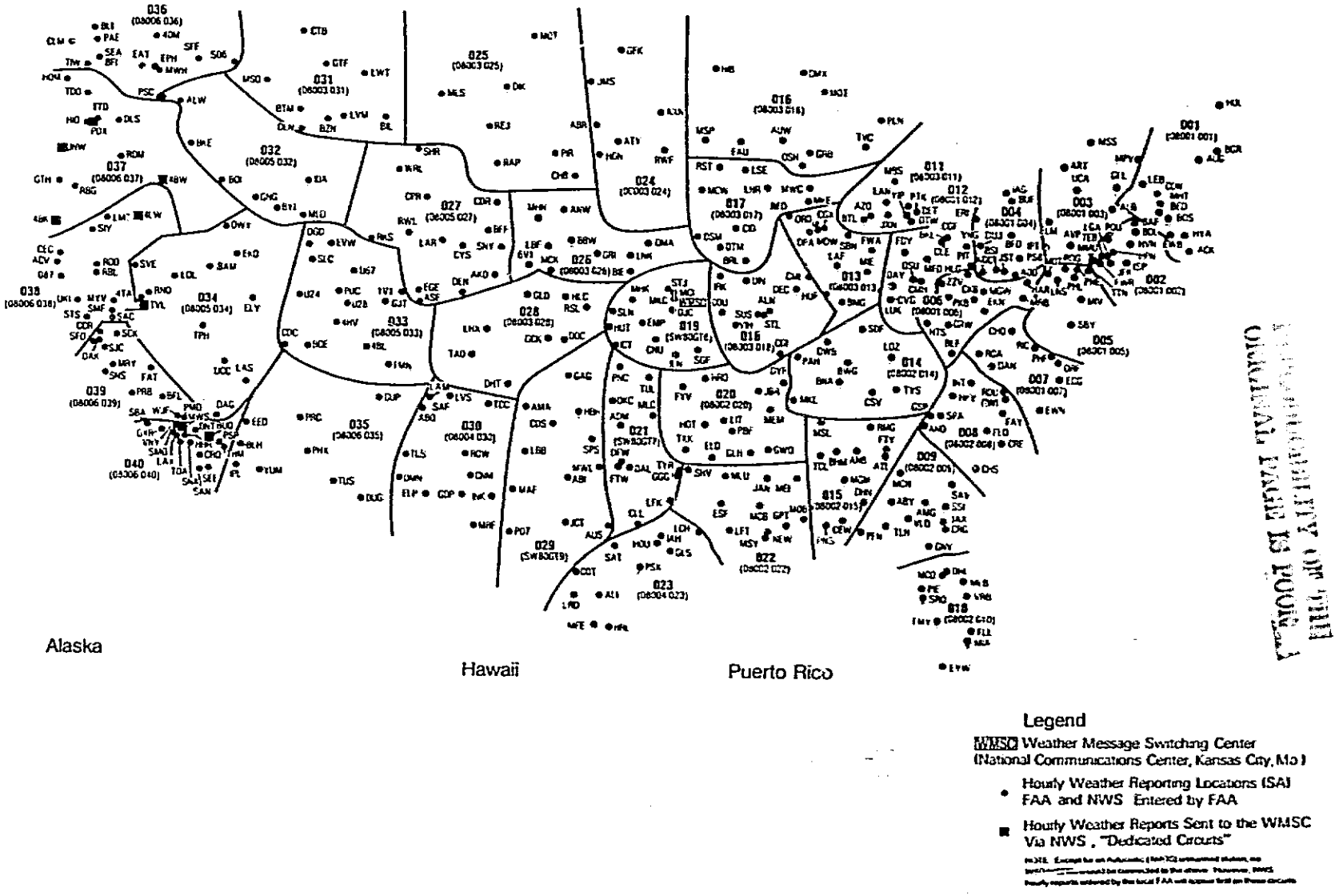


FIGURE 9-2. SERVICE A TELETYPEWRITER SYSTEM (FAA AREA CIRCUITS)

- NWS - This Government network contains 18 100-wpm area circuits and individual 100-wpm WSFO circuits, as illustrated in Figure 9-3. All WSO/WSFOs are connected to some NWS area circuit. If they have a send/receive connection, WSO/WSFOs enter their report directly on the local NWS area circuit in response to a polling signal from the WMSC communication computer. However, if the WSO has a receive-only connection, the local FAA will enter the WSO's report on the local FAA area circuit. The WMSC services 53 point-to-point circuits to WSFOs: one to each of the contiguous states, three in Alaska, and one each in Hawaii and Puerto Rico. Fifty of these circuits are designated as FAWS in Figure 9-1.

- Non-Government - The non-Government network contains 16 100-wpm circuits and 2 special high-speed circuits serving major airline dispatch offices. In addition, high-speed circuits are provided to Mitre Corporation and ARINC.

- Military - One high-speed (1,200-baud asynchronous) circuit is provided to the Air Weather Network (AWN) computer at Carswell AFB, Fort Worth, Texas, and 15 multi-point circuits are provided to military installations throughout the 50 states.

- Special - The WMSC also services a number of high-speed (1,200-baud asynchronous and 2,400-baud synchronous) circuits to FAA facilities in Chicago, Atlanta, Washington, Atlantic City, and Leesburg.

Service A also carries aviation weather reports from Mexico, Canada, and the Caribbean. The data are received on high-speed channels connecting WMSC with the NWS computer (KWBC) at Suitland, Maryland, and the International Computer (AFTN) at NATCOM.

9.1.2 Service C Network

The Service C network, controlled by the WMSC, is used to collect and distribute basic surface and upper-air data as well as many weather service products. The system consists of seven circuits. Six cover the 48 states; one satellite circuit serves Alaska. Service-C-type data from Hawaii and Puerto Rico are disseminated via the WMSC Service O data network. The Service C network configuration is shown in Figure 9-4.

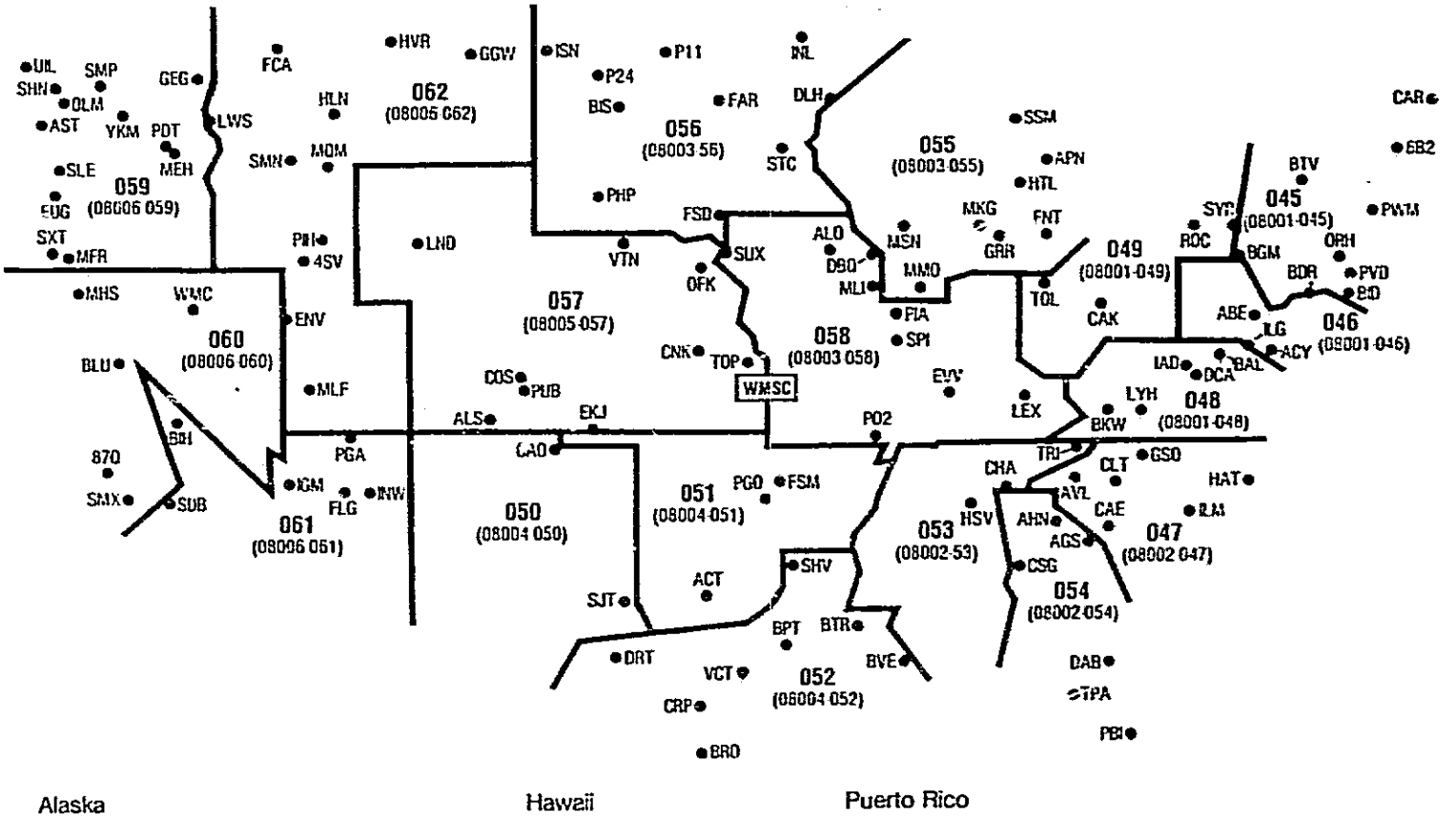


FIGURE 9-3. SERVICE A TELETYPEWRITER SYSTEM (NWS AREA CIRCUITS)

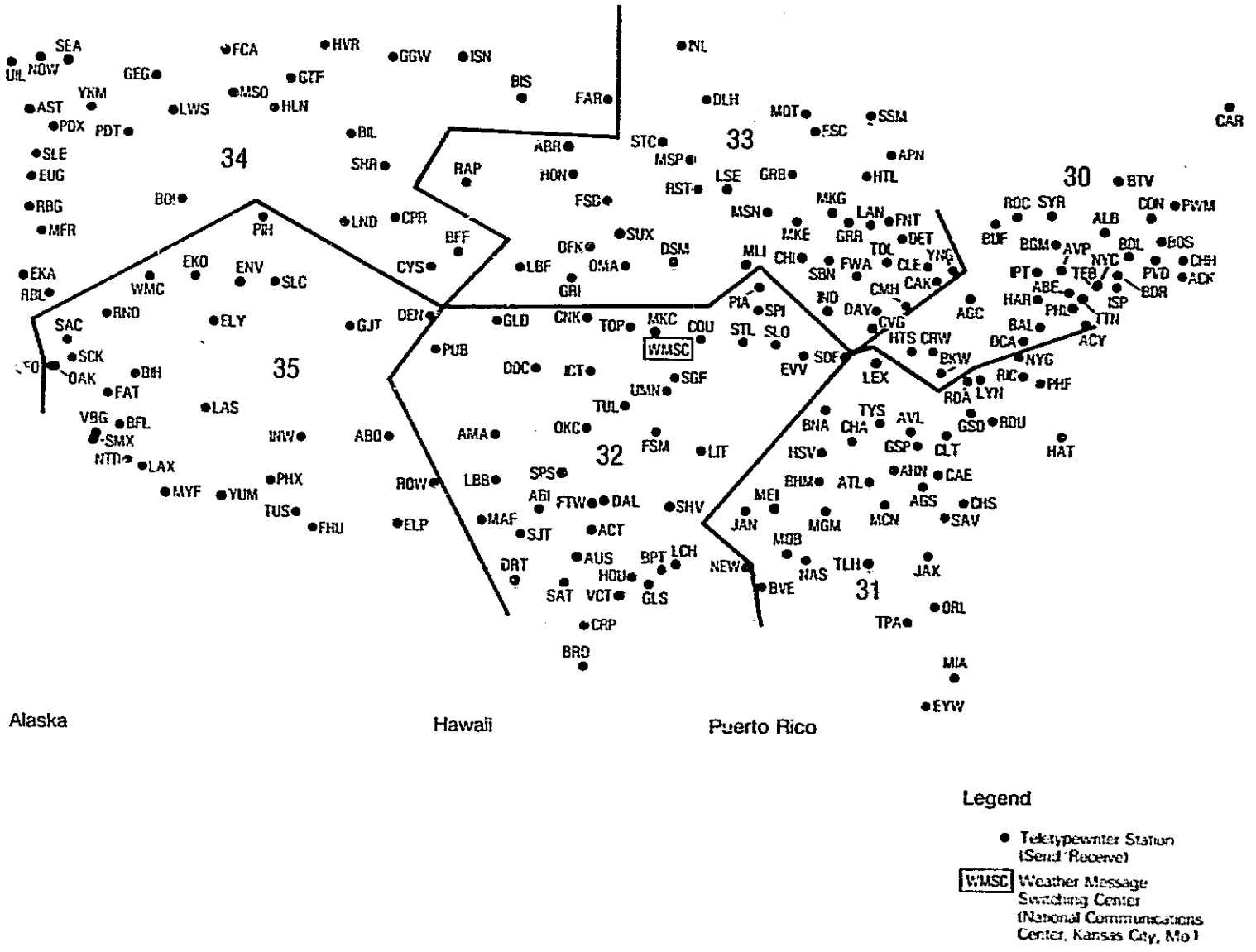


FIGURE 9-4. SERVICE C TELETYPEWRITER SYSTEM

Service C is a long-line, 100-wpm teletype network that is often designated as the meteorological network since it carries most of the U.S. surface synoptic and upper-air data. It also carries some reports from Canada and Mexico.

Practically all WSO/WSFOs are connected to Service C. Stations are polled according to a prescribed sequence for scheduled traffic and the data are relayed to other circuits in the network as needed.

9.1.3 Service O Network

The Service O Network accommodates the exchange of meteorological data between the U.S. and foreign countries and is configured as illustrated in Figure 9-5. The external relay points and the sources of the data are presented in Table 9-1.

Service O is a teletypewriter network consisting of long-line, radio, satellite, and cable circuits. The continental U.S. is served by nine 100-wpm long-line circuits. Data are relayed to most of these circuits by the NWS's communications computer at Suitland. Data are relayed by the FAA WMSC's communications computer at Kansas City to the remaining circuits and to and from foreign countries via radio and cable circuits. All the circuits are operated on an unscheduled first-in-first-out basis with appropriate priorities, with bulletins prepared in accordance with WMO standards. Operating procedures are determined by the FAA and schedules and content descriptions by the NWS. Agreements with WMO, ICAO, international WMO regions, and individual countries determine the data to be exchanged. The bulk of the traffic consists of synoptic and upper-air data.

9.1.4 WMSC Communications Front-End Processing

The WMSC system utilizes a Phillips Dual DS-7 minicomputer as a front-end processor. At present the processor functions primarily as a multiplexer. Developments are in progress to use this front-end processor to handle all communications functions, including multiplexing, data rate selection, polling, protocol management, priority control, and related functions. The system is capable of handling up to eight 9,600-baud lines and a proportionally higher number of lower-speed lines using either RS-232C- or CCIT-compatible protocols.

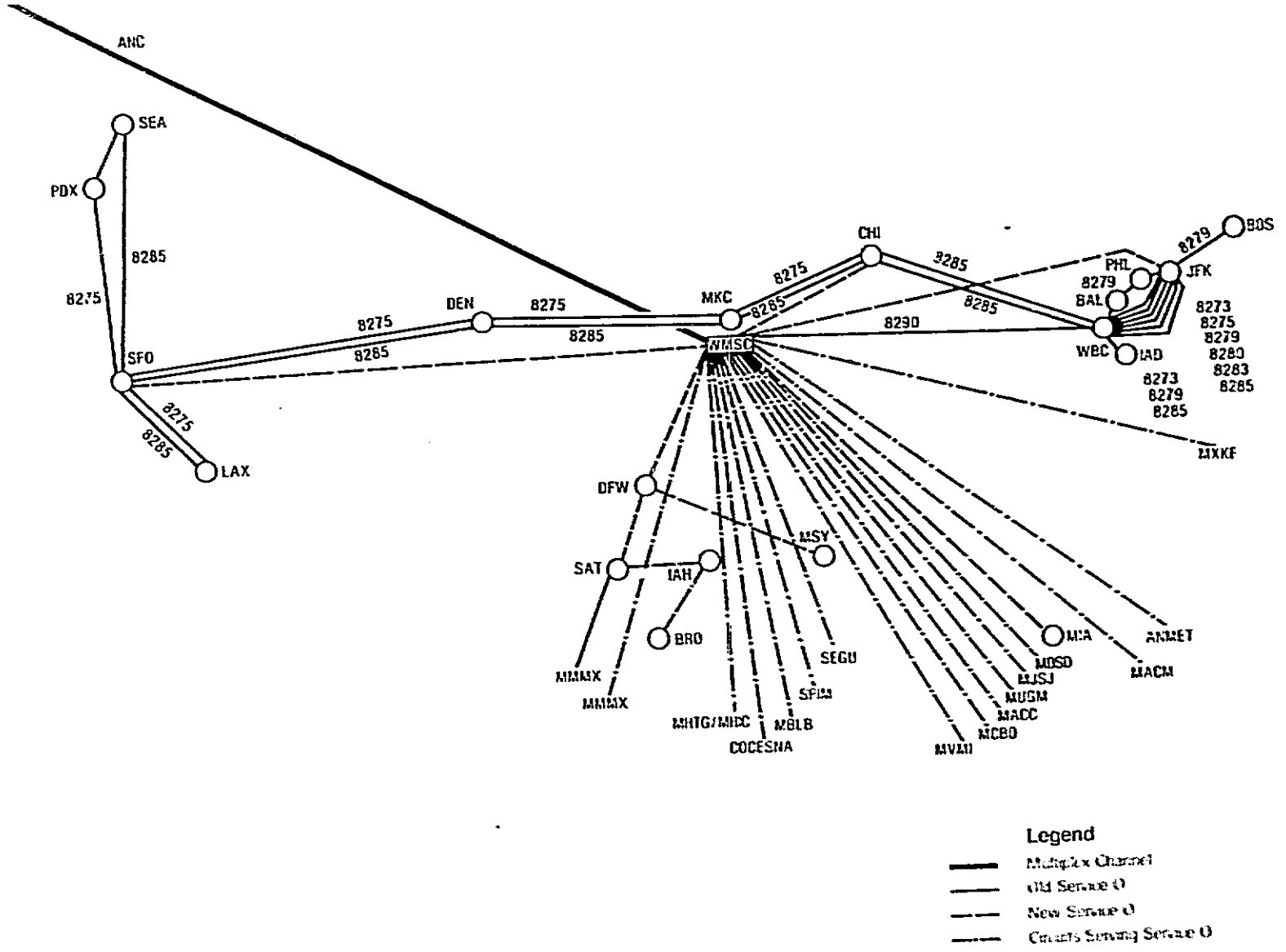


FIGURE 9-5. SERVICE O TELETYPEWRITER SYSTEM

TABLE 9-1. SOURCES AND EXTERNAL RELAY POINTS FOR DATA ON SERVICE O NETWORK

EXTERNAL RELAY POINT	SOURCE OF DATA
Mexico City, Mexico	Mexico
Swan Island	Swan Island, San Andres Island
Tegucigalpa, Honduras	Central America
COCESNA Circuit	Central America
Balboa, Canal Zone	Panama, South America
Lima, Peru	Peru
Guayaquil, Ecuador	Ecuador
Maiquetia, Venezuela	Venezuela, South America
Bogota, Colombia	Colombia
Curacao	Western Netherlands Antilles
Guantanamo Naval Base	Cuba
San Domingo, D. R.	Dominican Republic
San Juan, P. R.	Puerto Rico, Leeward Islands
Bermuda	Bermuda
Sint Maarten	Eastern Netherlands Antilles
ANMET, Trinidad	Lesser Antilles

9.2 AFTN DATA DISTRIBUTION ELEMENTS

The AFTN data distribution network is configured as illustrated in Figure 9-6. The network services Eastern Airlines, ARINC (which in turn provides international flight plan information for other airlines), WMSC, and other military, Government, and private users.

The system is designed to handle up to 159 circuits but currently uses 93 circuits (83 low-speed and 10 high-speed). The circuit types are as follows:

- 57 Frequency Division Multiplex (FDM)
- 16 Local
- 15 AT&T
- 5 Western Union.

9.3 A-BDIS DATA DISTRIBUTION ELEMENTS

The A-BDIS network services the FAA "B" circuits for the Air Traffic Service that are shown in Figure 9-7. The system supports 43 low-speed and 5 high-speed circuits, which are of the following types:

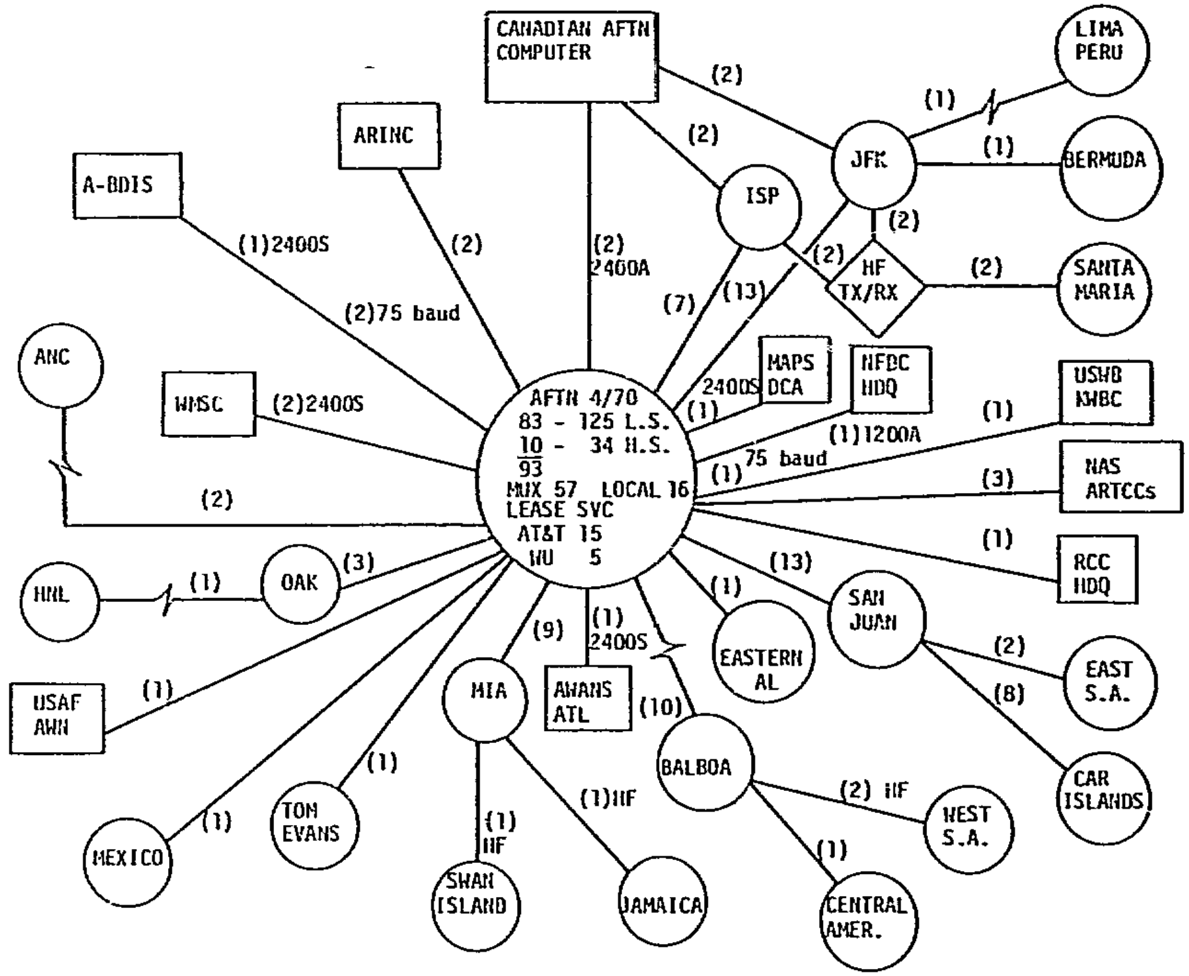


FIGURE 9-6. AFTN DATA LINE CONFIGURATION

- 1 Local
- 44 AT&T
- 3 Western Union.

Service B data interchange facilities are located in the following cities:

- Atlanta
- Boston
- Chicago
- Cincinnati
- Fort Worth
- Jacksonville
- Kansas City
- Longmont
- San Francisco.

9.4 NASNET DATA DISTRIBUTION ELEMENTS

The NASNET system consists of two circuits for data distribution: an East Circuit and a West Circuit. These circuits service the 20 ARTCCs in the U.S. on a polling basis to transmit FAA administrative and software implementation messages.

10. INFORMATION PRESENTATION ELEMENTS

Not applicable.

11. FUTURE CAPABILITIES/WORKLOAD

Several research and development programs that will affect the NATCOM are currently underway. These include Meteorological Aviation Presentation System (MAPS) and Automated Weather and Noting System (AWANS), Versions I and II. These systems are part of a project to determine whether the FAA can meet the projected needs of the flying public by Automated Flight Service Stations. All three systems are based on some form of the GTE IS/1000 minicomputer. MAPS provides only digital output; AWANS I and II provide both digital and graphic output, including both weather and flight data. These systems are currently being evaluated to determine which approach to take in the future for standard use in all FSSs.

Another change that is anticipated is the replacement of the 100-wpm Model 28 teletypes with 800 Data Terminal Equipment (DTE) systems, which consist of a controller, CRT, and high-speed magnetic tape units. These systems can operate at 2,400 or 4,800 baud, thus providing the FSS with faster access to the data base. Delivery of the DTEs is scheduled to begin this fall.